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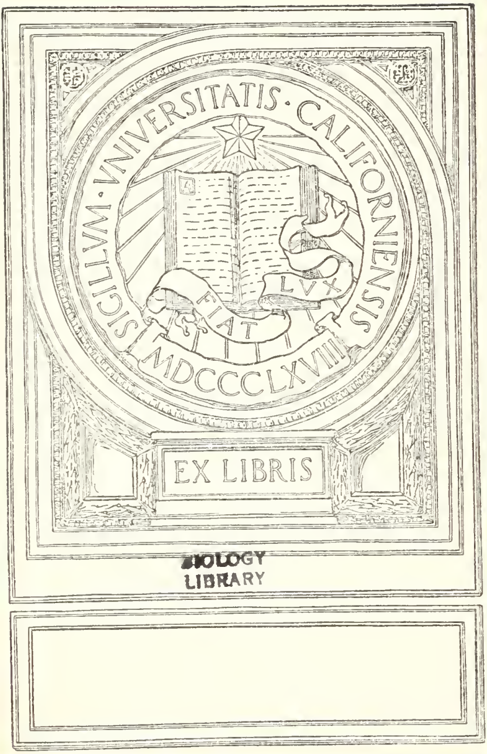

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Breathing Apparatus

(Rescue and Protective)

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Published by the
Bureau of Construction and Repair
in collaboration with the
Bureau of Medicine and Surgery
Navy Department

WASHINGTON
GOVERNMENT PRINTING OFFICE
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FOREWORD.

The purpose in issuing this publication is to provide the service with a handy reference pamphlet describing the several types of breathing apparatus and gas masks which are issued by the Bureau of Construction and Repair for use on board ship and stating the purpose for which each type is intended and the limitations of its use. Also a brief but clear description of normal and deleterious atmospheric conditions and the physiological effects of same on the human body, in order that the personnel may clearly understand why use of the apparatus beyond the limits for which it is intended may become extremely dangerous.

There are also included notes on first aid for persons overcome as a result of using breathing apparatus improperly or breathing impure air either with or without such apparatus.

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BREATHING APPARATUS.

(Rescue and Protective.)

STANDARD ALLOWANCES OF RESCUE BREATHING APPARATUS AND GAS MASKS FOR NAVAL VESSELS.

Standard allowances of rescue breathing apparatus, gas masks, etc., issued by the Bureau of Construction and Repair are as follows:

Oxygen Rescue Breathing Apparatus (navy yard, New York, type), leaflet specifications 65–A–1:	
Battleships, battle cruisers, first-class cruisers, scout cruisers, tenders, and supply ships—	
Rescue breathing apparaus, sets	12
Spare oxygen cylinders, in additon to the cylinders belonging originally to the outfit	48
Second and third class cruisers, fuel ships, and other auxiliaries in general—	
Rescue breathing apparatus, sets	6
Spare oxygen cylinders, in addition to the cylinders belonging originally to the outfit	24
Gunboats, destroyers, converted yachts, Eagle boats, patrol boats, and submarine chasers—	
Rescue breathing apparatus, sets	2
Spare oxygen cylinders, in additon to the cylinders belonging originally to the outfit	8
Navy Gas Masks, Mark II (head canister type):	
Battleships and battle cruisers	500
Cruisers and gunboats, 50 per cent of total complement.	
Destroyers	36
Navy Gas Masks, Mark I:	
Submarines, 1 for each person on board.	

NOTE.—The submarine board recommended that special protectors of simpler construction than gas masks be provided for submarines for protection against chlorine. As a matter of economy, however, the Mark I gas mask will be issued to submarines, as there are a large number on hand, and, excepting for size, they are in all respects equal, and in some respects superior, to a simplified protector.

Navy Ammonia Gas Masks:	
For vessels having ammonia refrigerating apparatus (in box containing four masks together with chemicals, etc.), set	1
Emergency Fire Hoods (sometimes called "smoke helmets"), leaflet specifications 33–H–1:	
Battleships, battle cruisers, first-class cruisers, tenders, and supply ships	12
Second and third class cruisers, fuel ships, and other auxiliaries in general	8
Gunboats, destroyers, converted yachts, Eagle boats, patrol boats, and submarine chasers	4

THE ATMOSPHERE, PHYSIOLOGICAL EFFECTS, AND FIRST-AID TREATMENT.

The following simplified statements in regard to normal air and the way changes affect a person's health are given in order that all concerned may be familiar with the rudiments of this subject, as it is a fact that very few, even educated men, fully understand the composition of the atmosphere and the effects of poisonous or other deleterious gases and proper methods of treatment of persons suffering from their effects.

Normal air (the atmosphere we breathe) is a simple mixture (not a chemical combination) of the following gases:

	Per cent.
Nitrogen (approximately)	78
Oxygen	21
Hydrogen and certain inert gases and traces of carbon dioxide (approximately)	1

Nitrogen and Hydrogen.

These gases have no effect on the human body other than to dilute the oxygen as well as carbon dioxide and likewise any poisonous gases which may be present.

Oxygen.

This gas is necessary to support life. Insufficient oxygen may be caused by fire or slow chemical absorption in unventilated spaces. Approximately one-fifth of the oxygen in each breathful of air is absorbed by the body. More oxygen is necessary when a person is active than when at rest. A person exercising violently may require as high as ten times as much oxygen as when completely at rest. The increased quantity is provided by deeper and more frequent breathing. The tissues of the body absorb a higher percentage of the oxygen which is circulating in the blood when a person is exercising. The greater demand for oxygen while muscular work is being performed is well illustrated by the fact that a person whose blood is partly saturated with carbon monoxide may be getting enough oxygen while at rest and may not realize that anything is wrong;

whereas, if he makes any considerable exertion while in this state, the fraction of the hemoglobin (the oxygen-carrying agent of the blood), which has not combined with carbon monoxide, may be insufficient to transport all of the oxygen needed, and he is liable to collapse. More oxygen is required when the large muscles of the body, those of the legs for example, are doing work than is required when smaller muscles only are in active use. A person at rest (at sea level) is unable to absorb a sufficient amount of oxygen when the proportion of oxygen in the atmosphere falls below 13 per cent, and unconsciousness occurs at 9 or 10 per cent. Unconsciousness occurs at higher percentages when a person is active. An analogy between the consumption of oxygen by the body and that consumed by a fire can not be drawn strictly, as life depends upon the actual quantity of oxygen present, whereas the burning of a fire depends upon the percentage of oxygen in relation to other gases present. In other words, a candle ceases to burn when oxygen in the surrounding atmosphere falls below 16 or 17 per cent, regardless of atmospheric pressure, whereas a person requires a higher percentage of oxygen on a mountain than he needs at sea level, because there is actually less oxygen in every cubic foot of mountain air, even though the percentage of oxygen is normal. If a lighted candle continues to burn in an unventilated compartment it may be assumed that there is a sufficiently high percentage of oxygen to support life. The point at which the flame is extinguished is but slightly above the danger point for human beings at sea level. A gradual decrease in the amount of oxygen to the danger point may not give any warning. As lack of sufficient oxygen deadens the faculties, a person not infrequently becomes unconscious without realizing that anything is wrong. Contrary to the usual belief, an increase in the percentage of oxygen even up to pure oxygen, causes no more oxygen to be absorbed for the performance of a given amount of work and causes no appreciable harm, although a certain amount of exhilaration may be experienced. First-aid treatment of a person overcome as a result of oxygen deficiency is described under " carbon monoxide," page —. It should be understood that death due to drowning or carbon monoxide poisoning is entirely due to the fact that the brain cells have been deprived of oxygen for a sufficient time to prevent recovery.

Carbon Dioxide.

This gas, sometimes called " carbonic-acid gas," is a chemical combination of one part of carbon and two parts of oxygen. It is usually liberated in nature by combustion (including slow decomposition of vegetable and animal matter) and by the breathing of animals. The oxygen taken into the lungs combines in the body with carbon, which is derived from food, and this chemical combination generates the heat which maintains body temperature. This carbon dioxide is given off through the lungs and passes out with the breath. Carbon dioxide in nature is in turn decomposed by the green coloring matter of the leaves of growing plants (chlorophyl), the carbon being absorbed in the growth of the plant, much of the oxygen being released. When air is rebreathed, as, for example, in a smoke helmet or in the breathing bag of an oxygen rescue breathing apparatus if the chemical absorbent is not working effectively, the carbon dioxide present gradually increases, causing headache or other symptoms. When the proportion of carbon dioxide rises to approximately 5 per cent a person experiences distinct panting. With 8 per cent the difficulty in breathing becomes distressing. The increase in the depth and rapidity of breathing experienced when exercising is caused by the increased amount of carbon dioxide accumulating in the blood and acting upon the respiratory center in the brain. It is by this means that the body secures the increased amount of oxygen needed and eliminates the excess of carbon dioxide. The want of oxygen has no direct effect on the breathing. It is the presence of too much carbon dioxide in the air breathed, whether due to rebreathing or derived from other sources, that causes the deeper breathing and finally panting as the percentage increases. A person thus has some warning when the proportion of carbon dioxide is gradually increasing, although dependence for safety should not be placed upon this. On the other hand, he has little or no warning when the amount of oxygen is dangerously decreased. The effects of an excessive amount of carbon dioxide are immediately overcome by fresh air.

Carbon Monoxide.

This gas is a chemical combination of equal parts of carbon and oxygen. It is formed by smoldering fires, or otherwise, when the amount of oxygen present at the point of combustion is not sufficient to provide two parts of oxygen for each part of carbon burned. Funnel gases, coal gas, gasoline-engine exhaust gases, illuminating gas, and the gaseous products of modern explosives are all rich in carbon monoxide. Many deaths have resulted from the use of portable charcoal stoves in poorly ventilated rooms. The vast majority of all cases of gas poisoning (asphyxiation) are due to carbon monoxide, and unless it is known definitely that some other poisonous gas, such as chlorine or one of the more potent warfare gases, is responsible, asphyxiation should always be regarded as due to carbon monoxide. Carbon monoxide is rightly classed as a dangerous poison, but in the strictest sense of the word it is not a poison at all, because although it combines with the red coloring matter of the blood and prevents the blood from absorbing a sufficient amount of oxygen, it really does not harm the blood in the least, and after the carbon monoxide has been eliminated the red coloring matter (hemoglobin) is in just as good condition to carry oxygen as before. Hemoglobin absorbs carbon monoxide in the same way as it absorbs oxygen, but the affinity of hemoglobin for carbon monoxide is between two and three hundred times as strong as its affinity for oxygen. The hemoglobin, therefore, takes up equal quantities of carbon monoxide and oxygen when approximately one-tenth of 1 per cent of carbon monoxide is present in the air. Death or serious after effects resulting from carbon monoxide poisoning is due to degenration of the delicate nerve cells in the brain caused by oxygen starvation and not to any direct effect on the body caused by the carbon monoxide gas. In air containing 2 to 5 per cent of carbon monoxide, death follows almost as quickly as in drowning. Roughly, it may be stated that a man who has breathed air containing 0.2 per cent of carbon monoxide four or five hours, or 0.4 per cent for one hour will die. The breathing of air containing lower percentages of carbon monoxide causes effects proportionate to the amount present and length of time breathed.

First-Aid Treatment of Carbon Monoxide Poisoning.

Resuscitation from asphyxiation by poisonous gases.—Carbon monoxide is the most important of the poisonous gases.

Promptly remove the victim from the poisonous atmosphere. If he is wearing any form of breathing apparatus, remove it. Keep him in a recumbent position. If he is conscious, do not allow him to exert himself. Notify the medical officer and send for oxygen.

If breathing is slow and irregular, or if it has stopped, as may be the case in sudden exposure to concentrated carbon monoxide, begin artificial respiration by the Schaefer prone-pressure method immediately at the nearest place where *fresh air* can be obtained. This method is fully described and illustrated on pages 46 to 53. To wait for a medical officer or any kind of mechanical resuscitation apparatus may mean the loss of a life which could have been saved by beginning artificial respiration at once and continuing without interruption. Even to delay while apparatus is being adjusted may be dangerous.

The Schaefer method of artificial respiration with the use of oxygen in suitable cases will save life where life can be saved. Where it fails, although properly performed, it may be assumed that mechanical resuscitation apparatus would have failed.

In *carbon monoxide asphyxia* just as in *simple asphyxia*—drowning, electric shock, or other form of simple asphyxia—the matter of primary importance is lack of oxygen in the tissues. Some of the most essential nerve cells in the brain suffer irreparable damage if deprived of oxygen for about 10 minutes. The heart continues to beat for several minutes after breathing stops, but with the muscles of respiration temporarily paralyzed oxygen does not reach the blood, and the heart soon stops beating effectively, the victim dying of asphyxia. The prime necessity is therefore renewal of the supply of oxygen to the blood before the heart stops beating effectively.

In simple asphyxia, artificial respiration by which the lungs are at once adequately supplied with ordinary air is a sufficient treatment. In carbon monoxide asphyxia the strong affinity between hemaglobin and the monoxide must be overcome before the blood can transport sufficient oxygen to meet the vital need of the tissues. To hasten the separation of carbon monoxide from the hemoglobin, pure oxygen should be administered if obtainable. If the victim is still breathing, oxygen may be administered from a tank through a bag and mask.

If the victim is not breathing, artificial respiration by the prone-pressure method must be given without interruption. However, with intelligent assistance it is possible to introduce sufficient oxygen in conjunction with the prone-pressure method materially to enrich with oxygen the air entering the lungs. The assistant should hold the mask to the victim's face during the inspiratory (release) movement and lift the mask a little during the expiratory (pressure) movement. If oxygen will serve its purpose it will do so in 15 or 20 minutes, and it is useless to continue the administration for more than half an hour.

In fatal carbon monoxide poisoning where the victim is still breathing when he is carried into fresh air, death results because of the insufficient supply of oxygen to the tissues during the time he was breathing the poisonous atmosphere. If serious degenerative changes have started, no amount of oxygen nor any other treatment can restore the damaged nerve cells. On the other hand, if the cells have not been seriously damaged, complete recovery may follow without any treatment other than removal to fresh air.

There is thus, in this as well as in simple asphyxia, a critical period beyond which recovery is out of the question. For an hour or more after relief measures are started it may be impossible for anyone to state whether the degree of poisoning has passed the danger point. It is therefore of the utmost importance to supply the cells with oxygen as soon as possible on the chance that the critical period has not been reached. Resuscitation efforts must be continued without interruption for several hours if necessary, or until a medical officer declares further effort futile. The subject may be profoundly unconscious and actually at the point of death from exposure to a concentrated mixture of carbon monoxide, yet if the duration of deficient brain oxygenation has not been too great, half an hour in the fresh air, with artificial respiration if necessary, will be enough to effect a seemingly remarkable recovery. On the other hand, long exposure to lower percentages may be fatal even though the subject is breathing when brought into fresh air. For example, when 60 to 70 per cent of the hemaglobin has combined with carbon monoxide, so that only 30 to 40 per cent remains available to transport oxygen, degenerative changes will start if the subject remains in that state for half an hour or longer, and death or at least serious nervous and mental impairment will follow in spite of treatment.

When the subject who is still breathing is brought into fresh air or when artificial respiration is begun while the heart is still beating effectively, the combination between carbon monoxide and hemaglobin begins to break up immediately, although separation is more rapid if pure oxygen is breathed. Even with ordinary air (20 per cent oxygen) the hemoglobin may be freed sufficiently in 10 or 15 minutes to transport the necessary amount of oxygen to the brain and other tissues. As a rule, practically all carbon monoxide is eliminated within six or eight hours, and the hemaglobin is then just as efficient as if the subject had never been poisoned. Clearly, the advantage of administering pure oxygen, or air enriched with oxygen, diminishes after the first few minutes, and ordinary fresh air will serve all purposes after the first half hour.

As a matter of fact, in a considerable percentage of the cases the subject does not recover in spite of rapid elimination of carbon monoxide. In cases where the symptoms are prolonged, impairment of vision and disturbances of mentality are not infrequent. Everything depends upon the length of time the tissue cells have been deprived of a sufficient supply of oxygen. Prompt recovery may follow after profound poisoning of brief duration; recovery is slow after long exposure to comparatively weak mixtures. Men constantly breathing air containing percentages of carbon monoxide too small to interfere with the oxygen-carrying power of the blood do not show symptoms or cumulative effects.

The victim of carbon monoxide poisoning should be kept warm. Bleeding actually diminishes the chance of recovery and should not be practiced. Symptoms of asphyxial coma indicate an intense acidosis. Water should be supplied to the system by the Murphy drip method. The administration of a 3 per cent solution of sodium bicarbonate intravenously may be of service.

Poisonous or Irritant Gases and Smokes.

These cause tears, sneezing, coughing, vomiting, irritation of the throat and lungs, etc. Certain of the gases simply make a person helpless for the time being, with no serious after effects, while others cause serious after effects or death, depending upon their concentration and length of time breathed. The gases most used during the World War were chlorine, bromine, phosgene, and so-called mustard gas. Many others, however, were used at various times. A more detailed description of the effects of such gases would be of no benefit, as treatment could only be undertaken by a medical officer. First aid should consist of removing the patient to fresh air, the administering of oxygen, and absolute rest. In the case of mustard gas, clothing which may have been wet by the liquid causing this gas should be removed and clean clothing supplied. Persons known to have been gassed, even if they do not feel the effects immediately, should under no circumstances undertake any work, and should, if possible, be carried to the first-aid station, as physical exertion or rest often means the difference between life and death.

USES AND LIMITATIONS OF EACH APPARATUS.

Oxygen Rescue Breathing Apparatus.

Provides complete protection against noxious atmospheres because the wearer breathes an artificial atmosphere, the necessary oxygen being furnished from a flask which is a part of the apparatus, and the carbon dioxide being absorbed by a chemical through which the exhaled air is passed before it is rebreathed. It should, therefore, be worn when entering compartments where the atmosphere is suspected of being irrespirable, for fighting fires, or for any other reason.

In order that this apparatus may be of real service in an emergency it is of the greatest importance that a considerable number of men be trained in its use. The training of only a few men is not sufficient, as it is always possible that the few trained men may not be on board when an emergency arises. It is of great importance that the men who have been trained in its use should also be thoroughly familiar with the arrangement of the ship and the access to all compartments.

It is very important that the rescue breathing apparatus be kept in first-class working condition, and that goggles, nose clips, etc., are kept in the box with the outfit. The oxygen cylinders must be frequently inspected to insure that the contents have not leaked out. Empty cylinders should be immediately replaced by charged cylinders. A stock of charged cylinders is kept at all navy yards.

Emergency Fire Hoods.

Afford protection against noxious atmospheres for a time not to exceed three to five minutes, depending upon the activity of the wearer, after which time the wearer will collapse. It is simply a large, loose bag fitted with goggles which, fitting closely around the neck, entraps a certain amount of fresh air which is breathed over and over. When this is vitiated the wearer must seek fresh air. Its advantage is that it may be slipped on quickly by any untrained man for quick action before the regular rescue crew can adjust their oxygen apparatus.

The emergency fire hood is particularly useful for closing a valve, shutting down a blower, etc., in a smoke-filled compartment. The wearer should always be provided with a life line, because difficulties may arise in connection with his mission which may prolong his stay in the compartment; or, under excitement, he may not notice the passage of time and be suddenly overcome.

Navy Gas Masks.

The Navy gas masks, Mark I (mouth canister type) and Mark II (head canister type) were developed to give protection against poisonous war gases. From the chemical point of view they give equal protection to the wearer, but the Mark II mask is the better for general shipboard use, as it interferes less with his duties.

In the absence of adequate protection the warfare gases are extremely effective in producing casualties. It is well known that carbon monoxide, which constitutes about 60 per cent of the gaseous products of combustion of all explosives in use, is dangerously poisonous, causing many prostrations and fatalities on shipboard. But the noxious gases now used in shells are from fifty to one hundred times as dangerous and effective as carbon monoxide. Lachrymatory gases are available which in concentrations as low as 1 part in 200,000 in the air so stimulate the tear glands as to keep unprotected men out of action. These are used particularly for temporarily silencing batteries.

The Navy masks will afford complete protection against hydrocyanic gas, cyanogen, cyanogen bromide, bromine, chlorine, phosgene, arsine, xylyl bromide, or benzyl bromide, and all other gases known to have been used or considered in modern warfare, with the exception of carbon monoxide. This gas is also liberated in considerable quantity by smoldering fires and is present in flue gases. Protection against carbon monoxide is therefore desirable irrespective of protection against war gases. It has not been found practicable to develop a chemical container which will absorb carbon monoxide. A special canister, interchangeable with the chemical canister on the Mark II mask has been developed which will afford protection from carbon monoxide by changing it to carbon dioxide (by catalysis), but this canister should not be used for protection against the war gases.

The question of furnishing these special carbon monoxide canisters for use with the Mark II mask for fire fighting has been considered, but as a gas mask furnishes no protection against lack of sufficient oxygen, which condition may be encountered in a closed compartment where a fire has been smoldering, it has been decided not to issue them. It therefore is obvious that gas masks should not be used for fighting fires.

Some of the so-called poison gases are really smokes. The gases proper are practically colorless and make their presence known by their effects upon the eyes, nose, throat and stomach. The smokes have in some cases the same effects when inhaled. They can usually be recognized by their color. However, in confined spaces, such as turrets, the smoke can not readily be seen and its presence is first indicated by the effect on the personnel. The filter pads shown in the cuts of the Mark II mask have been developed to absorb smokes, but as a sufficient quantity for general issue, had not been purchased when hostilities were discontinued, it was decided not to obtain and issue them until their need becomes urgent.

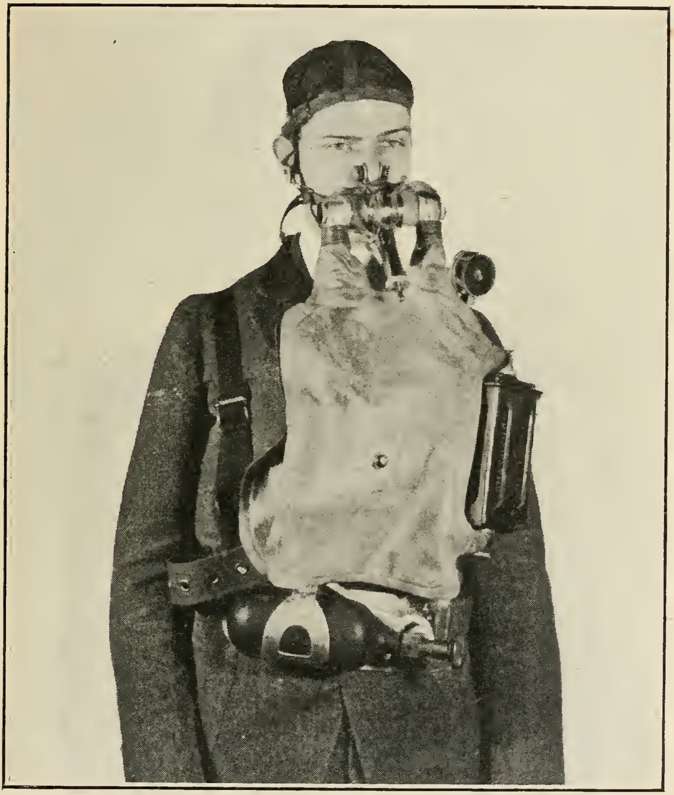
In land warfare it is possible to change, at short notice, the chemical and even the physical characteristics of the gas defense. Large organizations are maintained with armies in constant study of the subject. The Navy mask can not be modified frequently; therefore it has been planned to thoroughly meet possibilities of a maximum variety. No mask has yet been devised which will enable a man to work safely in the most deadly gases without imposing upon him some discomfort and some loss of efficiency. It is believed that the Navy masks interfere with the wearer's activities as little as is consistent with proper security. The head canister type is, of course, superior in this respect. Good vision has been secured by the use of glass eyepieces. All surfaces other than glass are quickly marred and vision is impaired to an extent not tolerable for naval purposes.

It is not recommended that the mask be worn into action. It should be used only when it is believed that noxious shells are being encountered. In noxious shells the greater part of the high explosive is replaced by liquefied gas. The explosion of these shells is relatively light. The indications of the presence of gas shells are shells exploding with slight detonation or blinds, men coughing or nauseated, men prostrated unwounded, or pronounced irritation of the eyes and weeping.

Ammonia Gas Mask.

This is the Navy Mark I gas mask fitted with a special canister containing special chemicals which absorb ammonia in lieu of the regular canister which is fitted to absorb war gases. This mask is issued only to vessels having ammonia refrigerating apparatus and should not be used for any purpose other than protection from ammonia.

OXYGEN RESCUE BREATHING APPARATUS (NEW YORK NAVY YARD TYPE).



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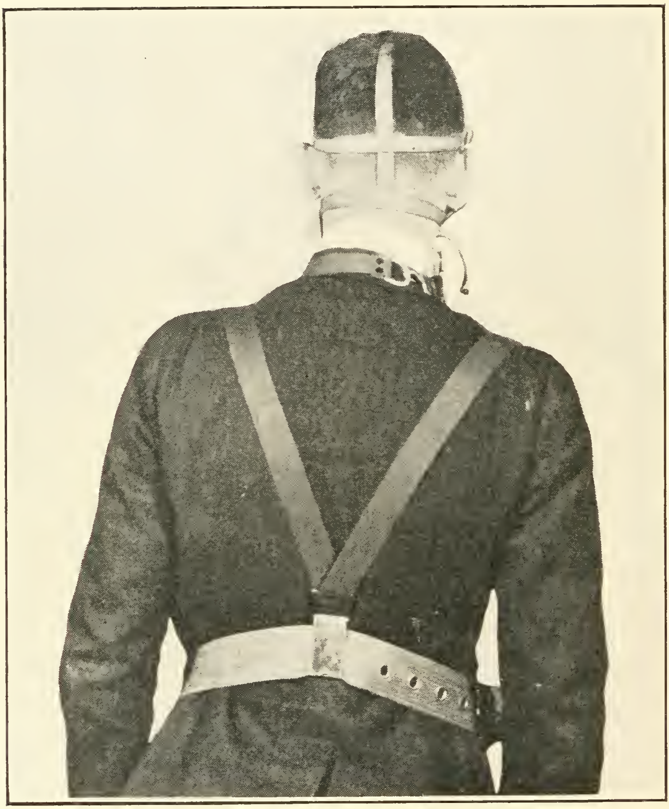

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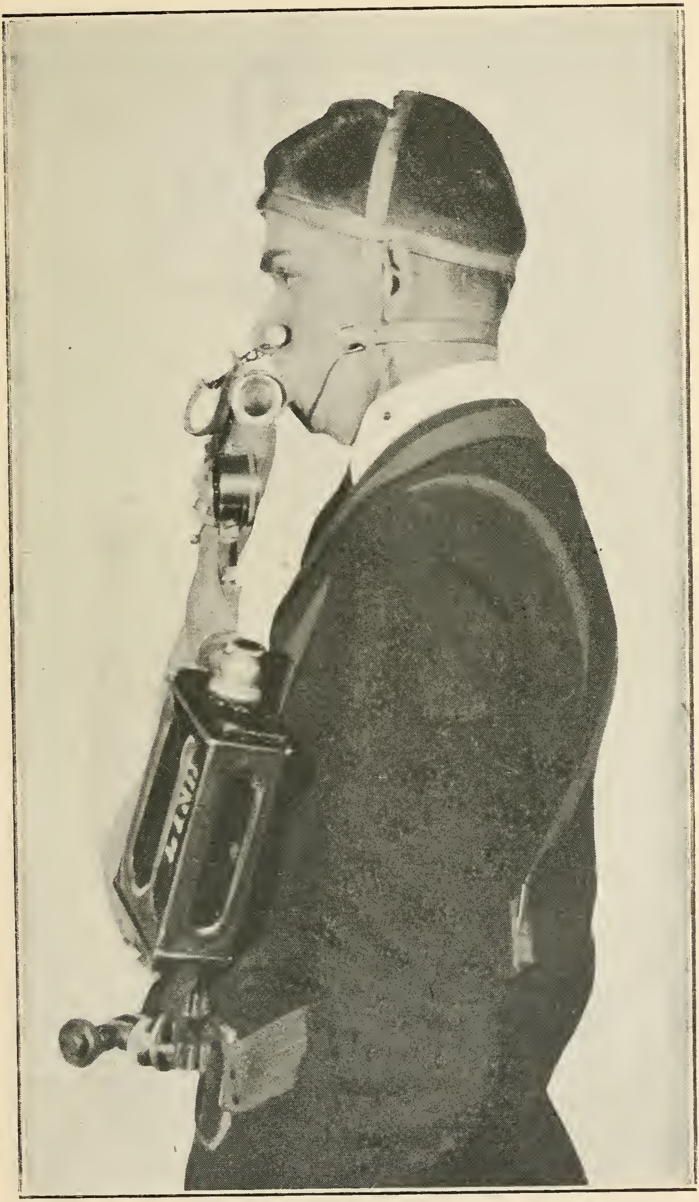

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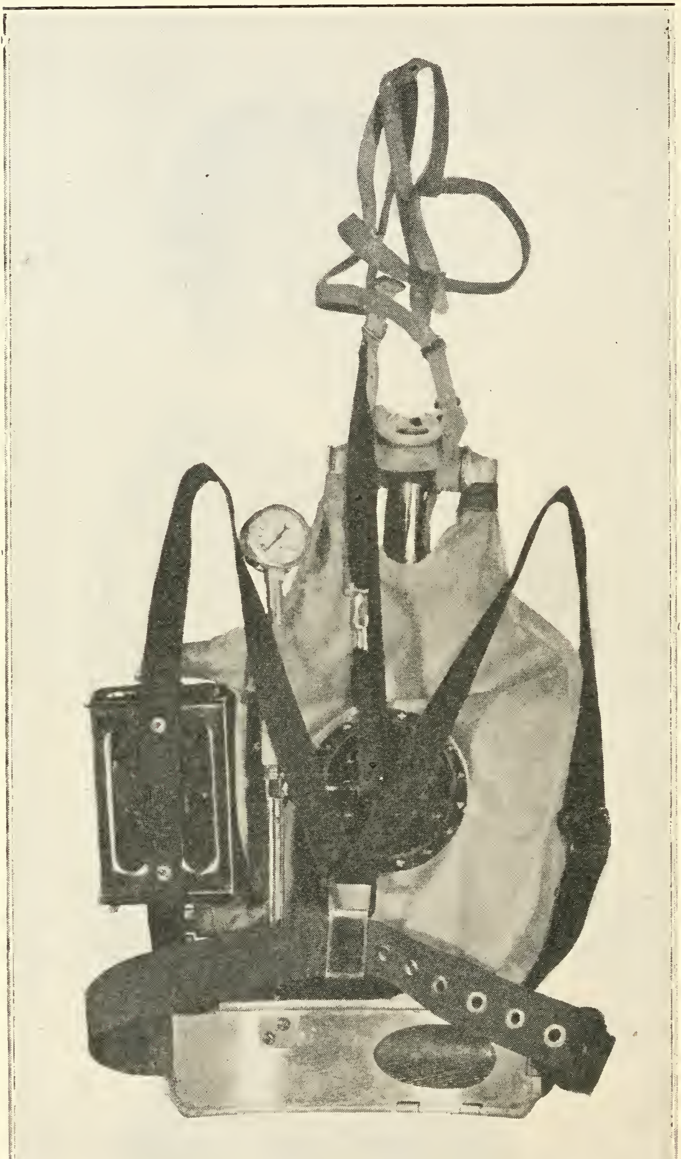

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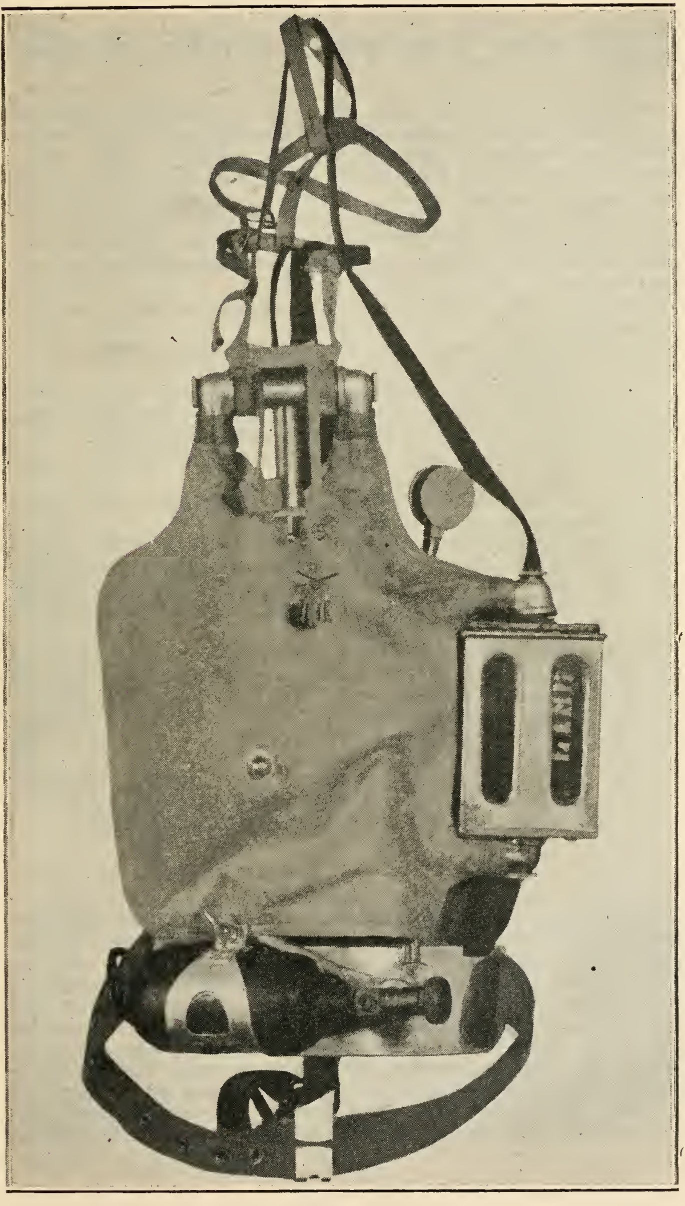


OXYGEN RESCUE BREATHING APPARATUS (NEW YORK NAVY YARD TYPE)—GENERAL DESCRIPTION.

The New York Navy Yard type rescue breathing apparatus has been developed to meet the special needs of the Navy where close spaces make it essential that the apparatus shall be extremely compact and light in weight. This apparatus enables the wearer to remain in an irrespirable atmosphere for a half hour while engaged in moderately hard work, weighs less than 15 pounds, and is of such compactness that the wearer can pass through the smallest apertures through which he can pass his shoulders.

The Navy type oxygen rescue apparatus consists of the following parts:

(*a*) A rubber mouthpiece which is held in the mouth by a headgear.

(*b*) A breathing chamber containing two mica valves which prevent the air from being rebreathed without passing through the absorption cartridge.

(*c*) A saliva trap attached to the breathing chamber which collects excessive saliva.

(*d*) An absorbing cartridge which extracts the carbon dioxide from the exhaled air.

(*e*) A rubber-lined breathing bag which acts as a combined reservoir for the unconsumed oxygen exhaled and fresh oxygen supplied by the oxygen supply tank. The bag, being elastic, accommodates itself to the action of the lungs.

(*f*) A steel cylinder which contains sufficient oxygen at an initial pressure of 1,800 pounds per square inch to provide the wearer with oxygen for one-half hour.

(*g*) A high-pressure gauge calibrated to indicate the length of time in minutes the wearer may remain in the irrespirable atmosphere.

(*h*) An internal automatic valve which reduces the pressure of the oxygen in the oxygen cylinder from 1,800 pounds to approximately 1 pound pressure.

OPERATION OF APPARATUS.

As the wearer of the apparatus exhales, the air from his lungs passes into the breathing chamber through the mouthpiece, thence through the absorption cartridge, which absorbs the CO_2 and allows the uncombined oxygen (and nitrogen if there is any left) to pass into the breathing bag. The absorption of oxygen by the body causes a decrease in volume of the air in the breathing bag which, in flattening out, allows a weight to come in contact with and operate the automatic oxygen-inlet valve which supplies fresh oxygen to the bag.

Those unfamiliar with the necessity for the obviously uncomfortable tight-fitting mouthpiece and nose clip frequently suggest that these features be eliminated by the providing of a mask face piece or helmet covering the entire head into which the wearer would breathe through his nose, leaving the mouth free for conversation. It is, therefore, stated for general information that extensive experiments carried on by the Bureau of Mines prove conclusively that to provide a mask or helmet would be a most dangerous procedure for the following principal reasons:

(*a*) One of the most serious defects which may be encountered in such apparatus is leakage of irrespirable gases into the system either through breaks in the material or around the edges of the face piece or helmet. It is *possible* to adjust a face piece or helmet so that it is gas tight; but this can not be depended upon, and in case of the slightest leakage the danger is very great. Leakage through a crack in the material which is too small to allow water to drip through may be sufficient to cause the death of the wearer, because the air is breathed over and over again, and the accumulation, due to even the slightest leakage over a considerable period of time, results in dangerous concentration. It will be noted that in the gas mask air is not rebreathed.

(*b*) The other reason is too much carbon dioxide in the rebreathed air. With a mask or helmet a considerable percentage of the rebreathed air does not circulate through the regenerative chemical, and the carbon dioxide soon increases to a point where it causes severe headache and other symptoms. The headache is usually attributed by wearers to pressure on the head, whereas it is in reality due to carbon dioxide.

When oxygen produced by the electrolytic process is used, care should be taken to see that it does not contain a perceptible amount of hydrogen (which may be produced by temporary reversal of polarity), as the concentration of this hydrogen in the rebreathed air would gradually increase, and ultimately all of the hydrogen which was originally in the oxygen cylinder would accumulate in the breathing bag and lungs.

DETAILED DESCRIPTION OF APPARATUS.

Nose Clip.

Although the nose clip furnished with the Navy rescue apparatus represents the best type available at present in that it effectively compresses the nostrils, thereby excluding noxious gases and may be worn with comparative comfort, it, like other types, can be easily displaced. In actual rescue operations it has frequently happened that nose clips have been knocked off. If the wearer should fail to find and replace the nose clip immediately the results would be serious. For this reason the nose clip should be adjusted to the nose in such a manner as to be not easily dislodged and should remain, as furnished, secured to the headgear.

Saliva Traps.

One of the drawbacks of the mouthpiece is that it stimulates in many men a copious secretion of saliva. This is liable to be discharged in the breathing chamber. To overcome this difficulty a saliva trap has been devised which forms an integral part of the breathing chamber. The trap should be opened every 10 minutes or more frequently if the accumulation of saliva is such as to interfere with the wearer's breathing.

Goggles.

The goggles furnished with the Navy type of apparatus represents the best type available. The rubber frame of the goggles should be moistened with water so as to secure a gas-tight connection with the face. Wetting the goggles by dipping in water prevents to a large degree the fogging of the glass. Smearing the glass with dry soap and polishing off with a dry cloth is also effective.

Mouthpiece.

It will be noted that the rubber mouthpiece is secured to the breathing chamber by means of a slip joint and to the headgear in a similar manner. This enables the wearer to adjust the mouthpiece to secure comfortable pressure on his lips and to center the mouthpiece. It will be found that the headgear holds the mouthpiece tightly to the mouth, and for this reason it will not be necessary to grip tightly with the teeth the two small rubber lugs forming part of the mouthpiece. These lugs are primarily used to cause the separation of the teeth, and should not be gripped too tightly by the teeth as this will cause a copious flow of saliva.

Oxygen Cylinders.

The steel oxygen cylinders furnished with the apparatus have a capacity of about 1¾ cubic feet of oxygen at 2,250 pounds pressure. This quantity is sufficient to enable the wearer of the apparatus to live in an irrespirable atmosphere for one-half hour while performing moderately hard work. It is possible, however, that in transit the valves on the oxygen cylinders may have been disturbed by careless handling, thereby causing them to be slightly opened and permitting the gas to escape. It is therefore necessary to test each cylinder for the amount of gas contained by noting the pressure indicated on the gauge after the cylinder has been secured in place on the apparatus. As has been stated above, the gauge should indicate, with a full cylinder, slightly less than 30 minutes on the dial. If, however. the gauge indicates considerably less than 30 minutes on the dial, the indication should be noted and the wearer cautioned to remain in the irrespirable atmosphere for a time corresponding only to that indicated on the gauge.

While the oxygen cylinders are intended to carry oxygen compressed to 2,250 pounds pressure, the oxygen compressors on hand at the principal navy yards (those used in connection with the oxyacetylene welding outfit) are rated at only 1,800 pounds. This pressure corresponds with about 25 minutes on the gage. Fresh cylinders registering this pressure therefore should not necessarily be suspected of leakage.

Soda Lime.

The absorbing material furnished in the absorption cartridges consists of soda lime and is the same as that used in air purification in submarines. It is manufactured at the navy yard, New York. The material is corrosive to the extent of affecting the hands, when same are exposed to the lime for considerable periods, and destroying the tin lining of containers if same are not covered by some protective coating. For these reasons it should be handled with caution.

Active Soda Lime.

Soda lime when in operating condition becomes heated by chemical union with carbon dioxide gas as the latter passes through the container. This production of heat is not as pronounced as in the case of caustic soda, the material used in commercial absorbers. Soda lime which has become inert due to deterioration does not absorb carbon dioxide gas and does not become heated by passage of carbon dioxide gas through the container, and for this reason a container which does not become heated should be turned in and replaced by another container.

In order that the soda lime in the absorbing cartridges may not be affected by contact with air during shipment and storage, the fittings at each end of the cartridges have been covered with a sealing compound or adhesive tape. This compound or tape can easily be removed with a penknife, care being taken to note whether any of the compound has become lodged in the thread of the fitting, in which case same should be removed before attaching the cartridge to the apparatus. The contact surface on the fitting of the cartridge with the couplings on the bag should also be scraped clean so as to produce a gas-tight joint with the couplings. One of the most important precautions to be taken in the adjustment of the absorbing cartridge and the securing of the breathing chamber to the apparatus is to insure that all couplings have been made absolutely tight, thereby preventing a leak permitting oxygen to escape or permitting noxious gases to enter the apparatus.

ADJUSTMENT OF APPARATUS ON WEARER.

The following instructions should be observed to facilitate the adjustment of the apparatus to the body:

(*a*) Secure the belt plate holding the oxygen cylinder, reducing valve, and pressure gauge to the body by means of the belt and buckle attached to belt plate. Secure shoulder straps and adjust height of belt plate by means of straps to a position which enables the wearer to stoop forward conveniently.

(*b*) Place headgear over head.

(*c*) Remove rubber plug from mouthpiece.

(*d*) Insert mouthpiece in mouth with rubber flange of mouthpiece between the lips and the teeth.

(*e*) Open oxygen cylinder valve one turn and note gauge reading, which should, with a cylinder charged to 2,250 pounds, indicate approximately 30 minutes on the dial.

(*f*) Allow oxygen to flow into bag until the latter is partially filled.

(*g*) Adjust nose clip to nose so as to constrict both nostrils, so that breathing is entirely through the mouth.

(*h*) Adjust goggles over eyes.

(*i*) Walk around and test tightness of all fittings on bag.

(*j*) If bag becomes filled to its maximum capacity and the gas continues to flow through the automatic regulating valve in the bag, the flow of gas should be stopped by closing the valve on the oxygen cylinder. If insufficient gas enters the bag to inflate it, the wearer should retire from the irrespirable atmosphere and remove the apparatus. The automatic valve should be examined by one familiar with its construction and the cause of the failure to close removed.

(*k*) Attempt to swallow saliva, but if same appears to collect, open gently the valve on saliva trap and allow saliva to flow out of chamber. Be sure to replace plug tightly.

CARE OF APPARATUS.

When not in use, the apparatus should be protected against dust, steam, and hot air. The rubber fittings should be kept in a ventilated cabinet in which a wet sponge is placed.

The apparatus should be disinfected after use; after disinfection it should be wiped off with a weak solution of ammonia. Do not wash the rubber with hot solutions of soda.

Formalin appears to be best suited for disinfecting purposes and should be used in a 5 per cent solution. Commercial formalin is a solution of about 40 per cent formaldehyde gas in water. The solution to be used may be made by adding 1 volume of formalin to 19 volumes of water.

After being used, the tubes and bag, the mouthpiece, and the saliva trap should be washed, soaked in 5 per cent formalin solution for one hour, rinsed with clean water, and thoroughly dried.

The apparatus should not be packed in excelsior or sawdust unless it is wrapped well with paper to prevent dust from getting into the circulating system.

PRECAUTIONS IN USING APPARATUS.

Testing of Fittings.

Safety demands that when a wearer of an apparatus is surrounded by an atmosphere containing poisonous gases, there should be no leakage inwardly, and it is therefore essential that the wearer test each connecting joint to determine if same is tight, so as to prevent the entrance of noxious gases into the circulating system and also to prevent the escape of oxygen from the apparatus into the surrounding atmosphere.

Lack of Oxygen.

In a considerable portion of the fatalities among men wearing breathing apparatus the victim has been found to have torn off the mouthpiece. It is probable that in many of these cases the temptation to do this arose from an insufficient volume of air in the bag. One of the most terrifying sensations that a man can experience is to be unable to fill his lungs when he feels the need for breathing deeply. A man can hold his breath far better with full lungs than with them comparatively empty. Accordingly when the wearer of the apparatus experiences this sensation he is tempted to tear off the apparatus, even though he knows that the surrounding atmosphere is deadly.

This situation may arise from an insufficient oxygen supply coupled with considerable physical exertion. It arises in its most acute form, however, when the air is pressed out of the bag between the wearer's body and the ground when he is crawling through a low passageway.

Enforced Resting.

In many such cases men who have observed their training instructions have saved themselves by remaining calm, resting, and allowing the apparatus to "catch up" with their requirements.

In the Navy type of apparatus the danger of deflating the bag is very remote, as it is necessary in order to cause the escape of oxygen to force the gas out of the bag into the mouth and past the mouthpiece into the atmosphere. With some makes of commercial apparatus the tendency to deflation is augmented by the fact that the oxygen can escape into the atmosphere through a relief valve attached to the bag which opens automatically when the pressure in the bag has reached a certain point. In the

Navy type of apparatus the oxygen in the bag can not escape into the atmosphere, as there is no relief valve. If a bag becomes deflated, the wearer should rest, cease all exertion, compose his mind, and allow the bag to partially inflate. All wearers of apparatus must be cautioned not to exhaust the oxygen supply in the bag to the extent of total deflation, but to conserve the supply of oxygen, testing the bag for inflation by feeling with the hands the degree of fullness of the bag, and if the bag has a tendency to deflate with very little exertion on the part of the operator, to retire from the irrespirable gas.

Overcharged Breathing Bag.

A man may at times find himself in trouble because the breathing bag is too full. The back pressure upon the bag makes it difficult for him to exhale the air from his lungs and he may get the idea that he can not inhale. The stress from this cause may be quickly relieved by allowing the gas to escape between the lips and the mouthpiece.

Connections may work loose and interfere with the circulation. To be sure that the connections are in proper adjustment feel of them frequently.

Care should be taken, when crawling through low places, to not allow the front of the bag to be pressed against the automatic oxygen supply valve, as this will result in an overcharged bag.

Inactive Absorbing Cartridge.

The absorbing cartridge may not work properly, with the result that the air leaving it contains too much carbon dioxide; the wearer will then have headache and difficulty in breathing. The remedy is to expel part of the air in the breathing bag and to rest a few minutes, while getting a fresh supply of oxygen.

QUALIFICATIONS OF RESCUE MEN.

Evidently it is important that wearers of the rescue apparatus should be strong, healthy men. The wearing of breathing apparatus of any type is in itself equivalent to considerable physical exertion. In actual rescue work extreme demands on physical vigor are almost certain to occur. Every man who is to take part in rescue work should have been subjected to a thorough medical examination, particularly with regard to his heart, arteries, and kidneys. In general, he should be under 40 years of age; of good muscular development; accustomed to hard work; rather under than over the average weight for his height; and never fat. His arterial pressure when resting should not be more than 140 mm. of mercury.

The importance of permitting only carefully selected and thoroughly trained personnel to use oxygen rescue breathing apparatus for actual rescue work is illustrated from the following quoted report received from the New York Navy Yard:

" In the establishing of a rescue squad as an adjunct to the yard fire brigade, representatives from the hull division trained men selected by the public-works officer in the use of the Navy apparatus. For this purpose a small gas house was erected in which the men while wearing the apparatus were obliged to do active work in lifting weights, carrying same from place to place, exercising with chest machines, and crawling through a tunnel specially built for this purpose.

" It was found that those who had been selected by the yard surgeon as being physically in condition for this work, and after having satisfactorily used the apparatus in smoke without any apparent discomfort, failed in many instances to remain in a supposedly poisonous atmosphere due to the psychological effect produced. *A number actually fainted and when restored to consciousness claimed that they had inhaled the poisonous gas and could taste same, whereas, as a matter of fact, the atmosphere the men worked in was as devoid of poisonous gases as the outside atmosphere.* They had been told that the air in the gas house contained a deadly gas and to give credence to the statement, gas from a 200-cubic-foot cylinder of oxygen was allowed to escape in the room in view of the men.

" It is apparently highly desirable not only to educate the men in the theory of the use of the apparatus, but also thoroughly to select by a process of elimination those who are physically and mentally suitable for the work."

Physical Tests.

He should be subjected to a number of tests in regard to his capacity for vigorous exertion. Running up and down a flight of stairs as rapidly as possible 5 or 10 times with a total climb of 60 to 100 feet is perhaps as good a test as any. The pulse rate, condition of breathing, and arterial pressure should be observed before the test, immediately at the end of this exertion, every 5 minutes for 20 minutes thereafter, and finally an hour later. The arterial pressure is the least significant of the three methods of observation. In a healthy man it may be raised 30 or 40 mm. above the resting value for the individual. The pulse may be accelerated to more than double the resting rate, and the rate of breathing may be increased to the point of vigorous panting.

Index for Determining Qualifications.

The main distinction between a vigorous man and one who is unfit for rescue work is in the character of the recovery after such a test. Even within the first 5 minutes after cessation of the effort the pulse should fall approximately half way to its normal rate again and the respiration should have so far recovered that the man may speak easily. An hour later the pulse should be only few beats to the minute above the initial count. After such a test a vigorous man should experience or exhibit neither immediately nor later any feeling of discomfort or trembling of the limbs. In addition to such a test as this a man qualified for rescue work should be able to travel at least 10 minutes at a fast walk while wearing the apparatus under full service conditions without getting out of breath.

Heart Action.

The capacity of the man to make and withstand physical exertion is largely determined by the functional power of the heart. As an indication of this, however, the breathing is a more reliable single indication than either arterial pressure or the pulse. The pulse rate in one healthy man at rest may vary widely from that of another man; neither 50 nor 90 beats per minute is necessarily abnormal. It is probable that a man may be perfectly healthy with an arterial pressure of 100 or of nearly 140 mm. mercury. Furthermore, a heart may be perfectly capable of supplying all the ordinary needs of resting conditions and of moderate activity and yet during vigorous exertion it may be incapable of meeting the full demands of rescue work. In the latter case deficient circulation is evidenced more by violent breathing and prolonged subsequent breathlessness (or as expressed scientifically by the high respiratory quotient) than by any other indication. This is due to the fact that the breathing is controlled from the respiratory center in the brain, which is very sensitive to the character and the amount of blood pumped by the heart. Although it is difficult to formulate rules regarding this subject, a little experience in observing men under severe muscular tests enables the observer, who fixes his attention upon the breathing, to determine quite effectively whether or not the exertion is really beyond the subject's capacity.

When Not to Use Rescue Apparatus.

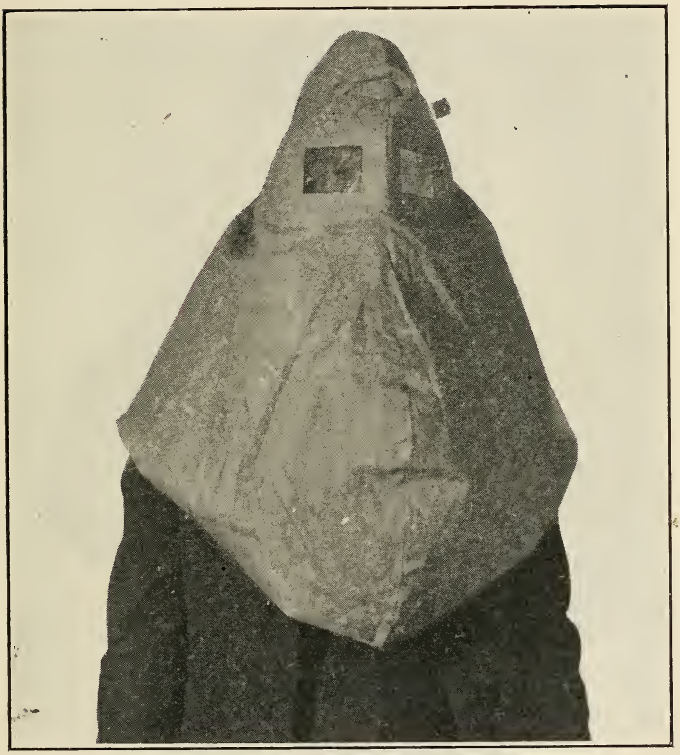
Rescue training preferably should not be undertaken within two hours after a meal. After having used the apparatus continually for two hours a man should rest for six or eight hours before wearing it again. The wearer should also rest frequently in the course of work or travel.

EMERGENCY FIRE HOOD.

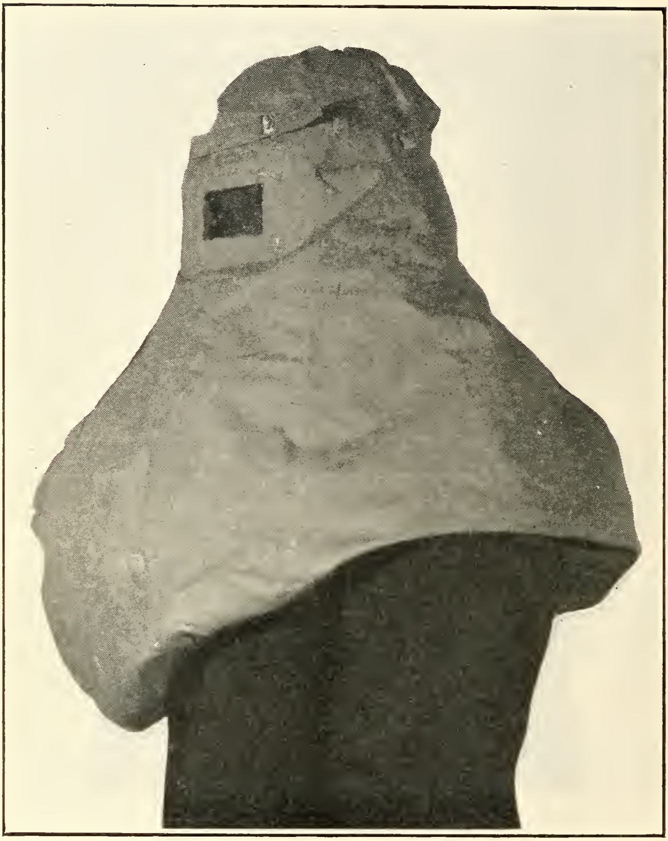
No special instructions appear to be necessary in regard to the use of this apparatus, excepting that as much air as possible should be entrapped when putting the hood on, and it should not be kept on longer than from three to five minutes. It should be understood that the oxygen entrapped in the bag will not last as long when the wearer is exercising as it would if he were at rest. Rapid breathing, due to excitement, will also exhaust the oxygen more rapidly than would be the case with a man of steady nerves.

A life line should always be attached to a man wearing the emergency fire hood when he is about to enter a dark or smoke-filled compartment.

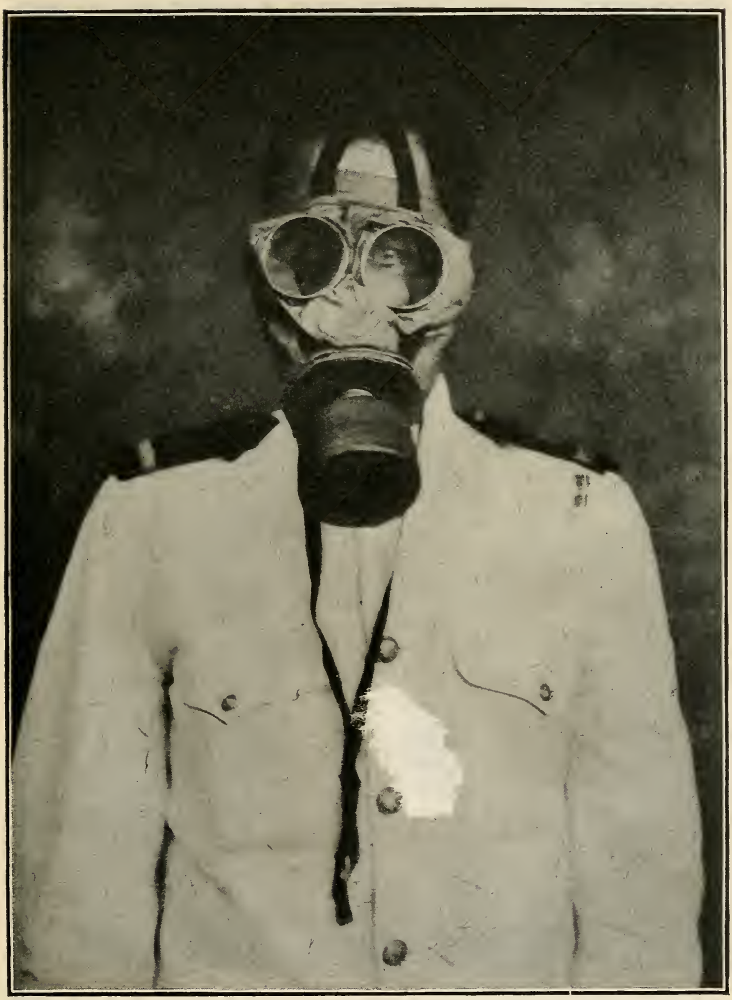
EMERGENCY FIRE HOOD.



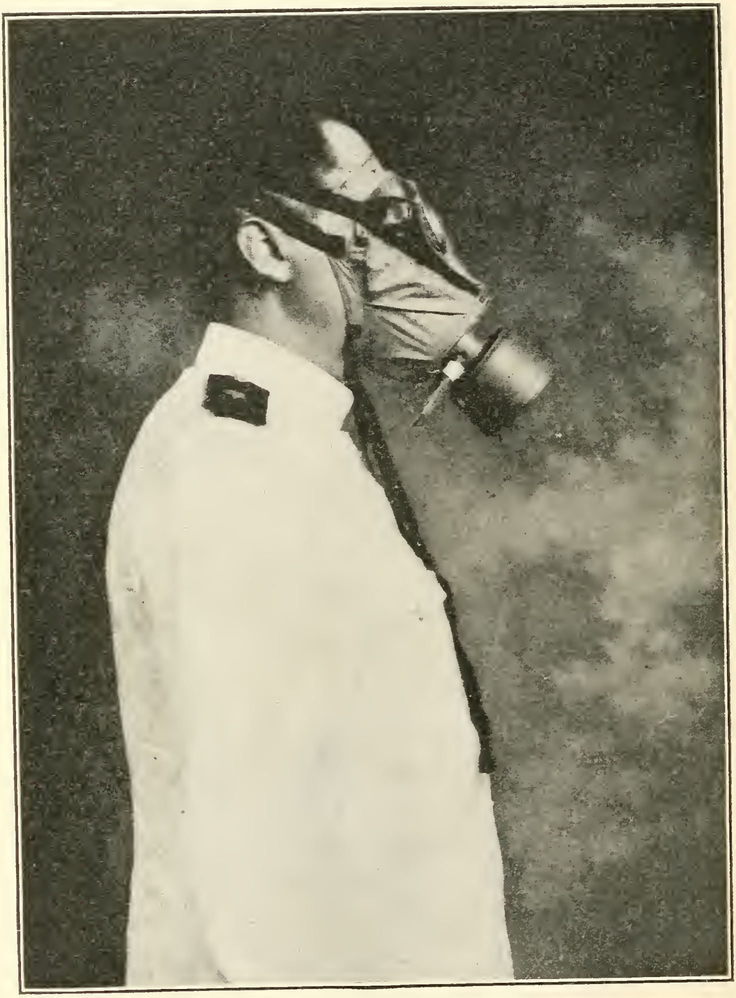
EMERGENCY FIRE HOOD.



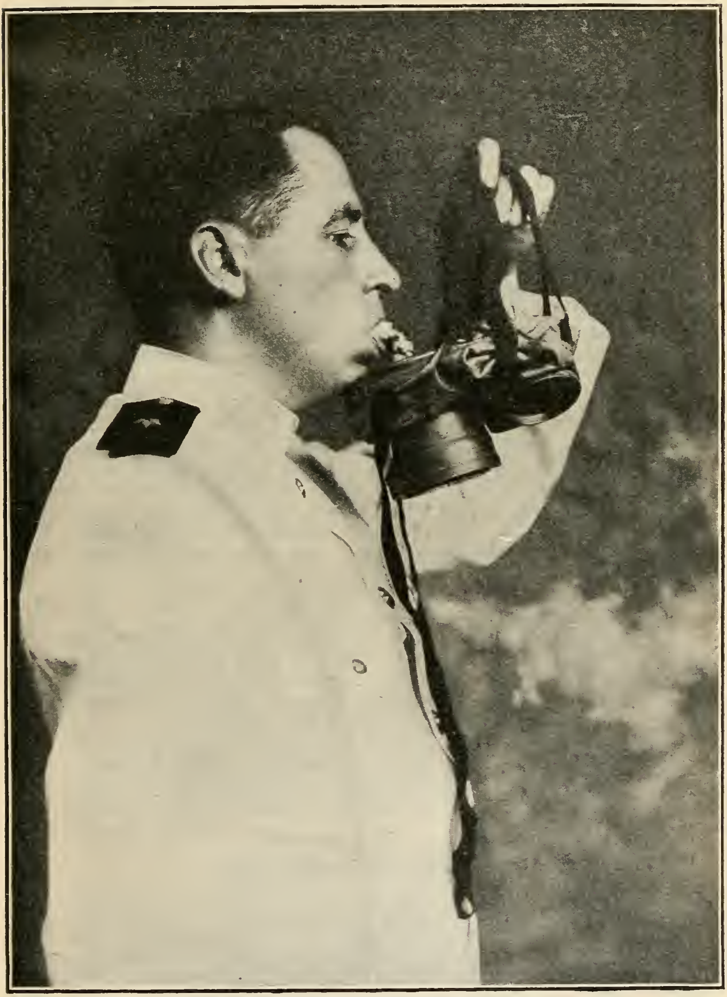
NAVY GAS MASK, MARK I (MOUTH CANISTER TYPE).



NAVY GAS MASK, MARK I (MOUTH CANISTER TYPE).



NAVY GAS MASK, MARK I (MOUTH CANISTER TYPE).



Method of putting on Navy gas mask.

DESCRIPTION OF NAVY MASK, MARK I.

The Navy mask is a composite of the English and German. In appearance, weight, and convenience it is the German mask, but functionally and chemically it is the English mask. Being self-contained on the head, and having no connecting tubes or straps, it imposes little restriction on the wearer's movements.

The chemical container is charged for a capacity of two and one-half to three hours' total exposure to effective gas concentrations. This should be adequate for many engagements, if the masks are properly cared for.

The breath is drawn in through perforations in the bottom of the container, passing through three layers of chemicals, then through the mouth tube and mouthpiece into the mouth. Nose clips close the nostrils; otherwise a man under stress would exhale through his nose, fouling his goggles and swelling up the mask like a balloon.

The mouthpiece is designed to fit perfectly between the lips and the teeth and gums; otherwise the man when excited would suck in breath from the corners of his mouth. The exhaled breath, therefore, passes out through the mouthpiece but can not pass out through the chemical container on account of a check valve which diverts the exhaled breath out through the rubber flutter valve. The purpose of this is to prevent partial saturation of the chemicals by exhaled carbon dioxide and also to prevent flooding with saliva which is carried away with the breath. For this reason the flutter valve should always be pointing downward, although not necessarily with precision.

The purposes of the mouthpiece, nose clip, and exhale valves. therefore, are:

(*a*) To protect the chemicals from saliva and carbon dioxide.

(*b*) To avoid the bellows action found in the German mask which swells up and deflates with each breath.

(*c*) To avoid dead air space and consequent rebreathing of the previously exhaled breath. This would reduce a man's working capacity very materially.

(*d*) To prevent constant accumulation of moisture on the inside of the goggles, especially in cold weather.

(*e*) To prevent possible traces of lachrymatory gases, if unabsorbed in the container, being drawn directly to the eyes.

INSTRUCTIONS FOR USE.

Masks should always be kept in the original cans which protect them from moist air and light. They should not be stored near steam pipes or in any other hot places. If masks become wet in use they should be dried before returning to cans. Punctures should be promptly patched with adhesive tape which is included in outfit. Masks torn beyond repair should not be used.

Regularly every week masks should be examined for defects. The glass eyepieces should be rubbed clean with a dry cloth.

then smeared with ordinary soap—not wet—then again polished with a dry cloth. This prevents mist from forming on the inside of the glass when the mask is put on. Occasional mist may form in spite of this treatment and may be removed while the mask is in place on the head by inserting the thumbs in the loose fold of fabric adjacent to each eyepiece and rubbing the inside of the glass.

The chemical containers ought never to be unscrewed from the mask. In case this is done, however, it will be noted that several rubber washers are provided to make a tight seat. Any one of these is sufficient, and one or more may be omitted if necessary to secure tight fit with the rubber exhale valve pointing downward. The container needs to be screwed up with moderate force only.

The wire frame of figure 8 section is for holding the goggles in position like a spectacle frame. It may be snapped into position over the goggles when desired and will be found an aid to vision. In returning the mask to the can, it is important to first remove the wire frame, then place the mask in the can, then push the wire frame in beside it, taking care not to injure the fabric.

APPLYING THE MASK.

In applying the following procedure is recommended:

(*a*) Hold outfit in the right hand, the bottom of the chemical container resting in the palm of the hand, and with the opening of the mouthpiece directly toward you.

(*b*) See that the elastic straps are not entangled.

(*c*) Draw the fabric of the mask downward as far as possible and clear of the dish-shaped metal piece.

(*d*) Insert the mouthpiece between the lips and gums and grasp the projections firmly with the teeth.

(*e*) With both hands grasp the elastic straps on each side of center and draw them carefully over the forehead to the back of the head, the lower ones passing just above the ears.

(*f*) With both hands draw the fabric under the chin toward the throat until it is fully and smoothly extended.

(*g*) Apply nose clip to the nostrils. This helps adjust the goggles.

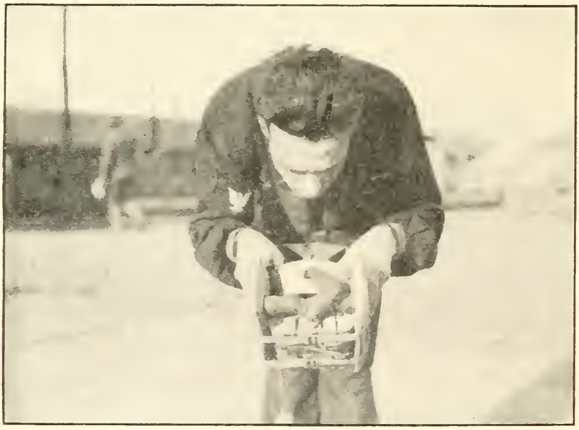
(*h*) Adjust the straps and the upper edge of the fabric to a comfortable position and so that the goggles are properly located.

(*i*) In removing mask always first carefully draw the elastic straps forward from the back of the head. This releases the entire outfit without strain.

(*j*) The procedure should be practised. The outfit can be readily applied and adjusted in five seconds without danger of tearing or breaking any of the parts.

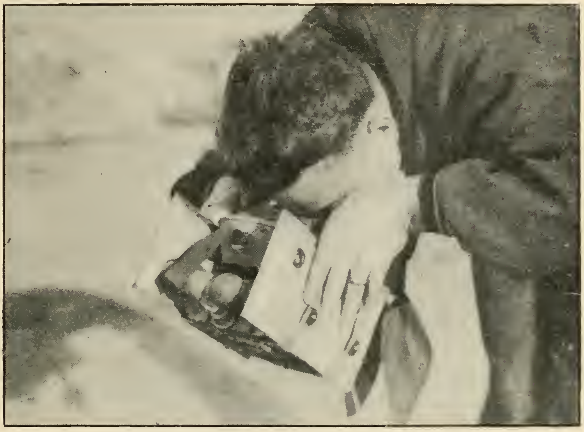
NAVY GAS MASK, MARK II (HEAD CANISTER TYPE).

Ready position.

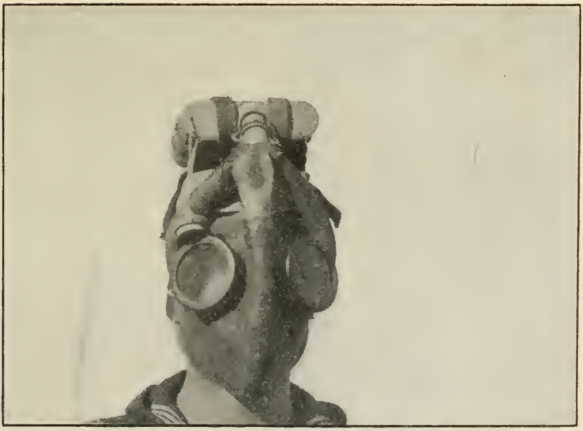


Thumbs spread part of face piece passing under chin.

NAVY GAS MASK, MARK II (HEAD CANISTER TYPE).

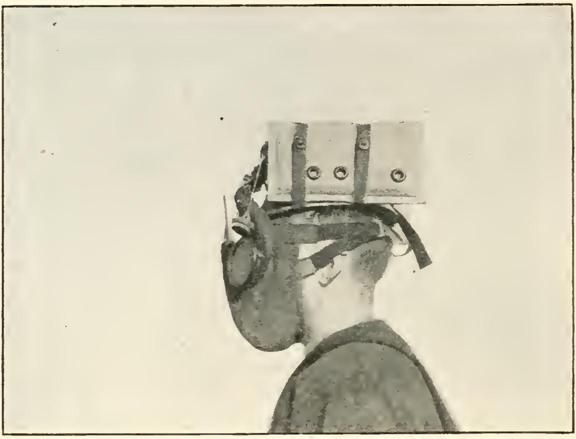


Chin inserted—ready for back throw.

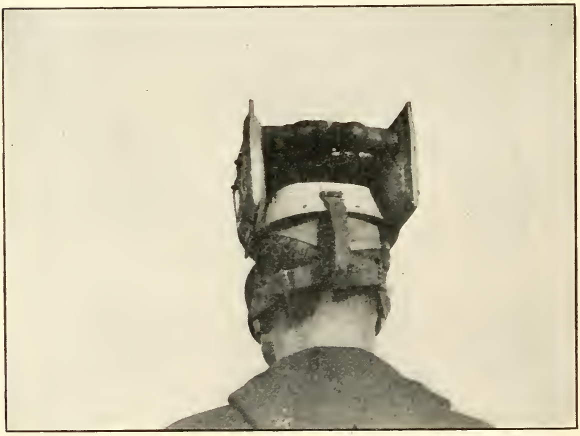


Front view—filters removed.

NAVY GAS MASK, MARK II (HEAD CANISTER TYPE).

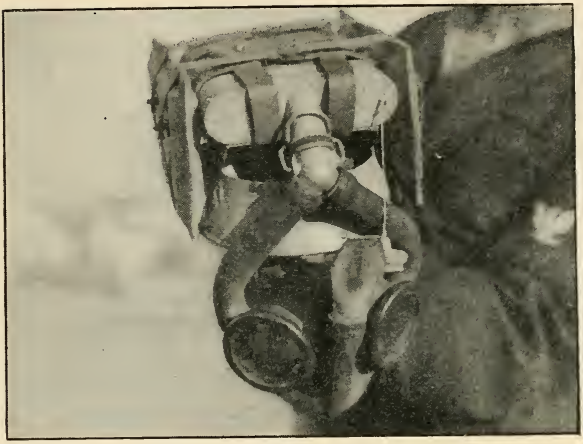


Side view, showing adjustment of elastic webbing.

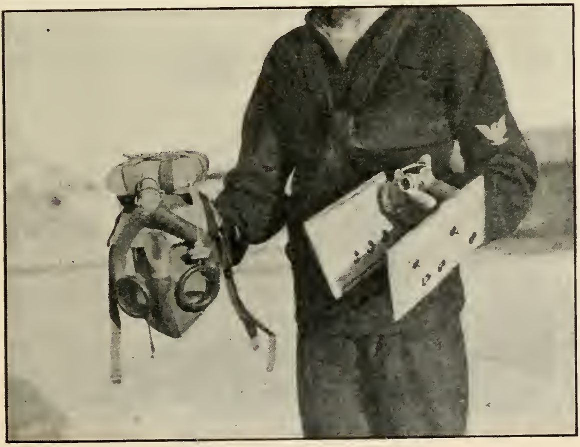


Rear view, showing filter connection.

NAVY GAS MASK, MARK II (HEAD CANISTER TYPE).

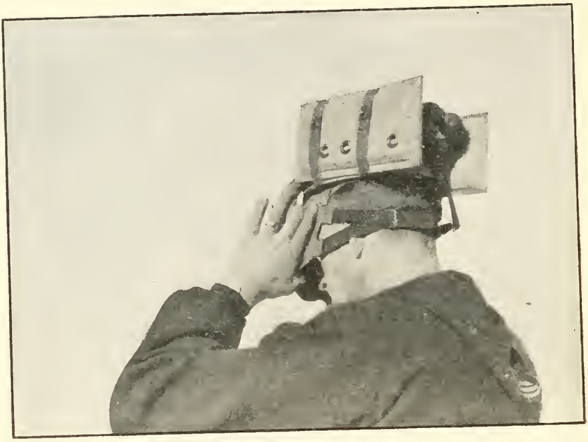


Close-up, showing detail of retaining straps and connection to mask from canister.

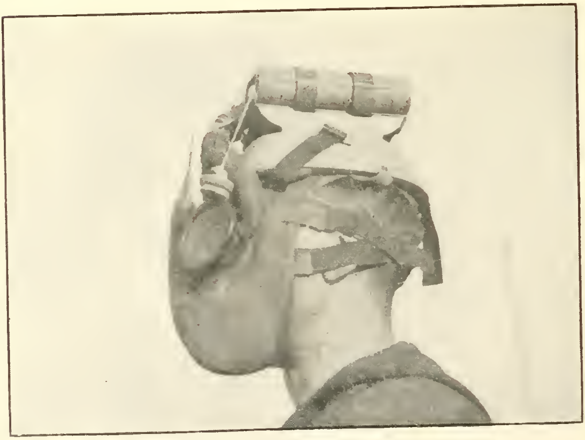


Showing filter pads removed from helmet.

NAVY GAS MASK, MARK II (HEAD CANISTER TYPE).

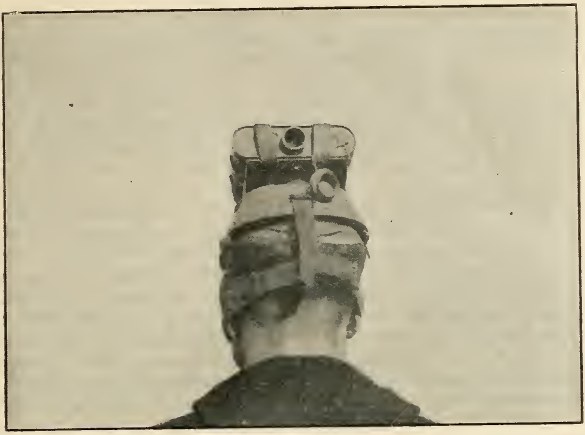


First position in removal of mask.

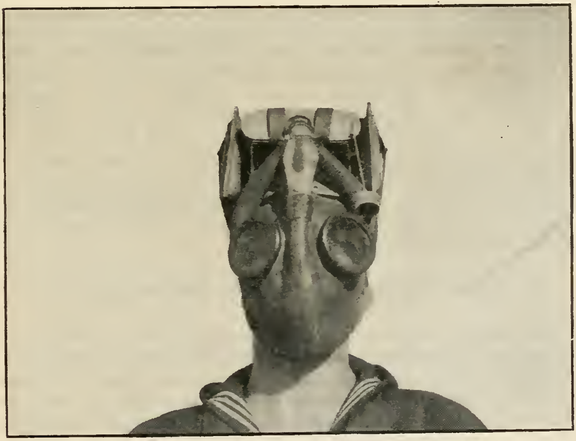


Side view—filters removed.

NAVY GAS MASK, MARK II (HEAD CANISTER TYPE).



Rear view—filters removed.



Front view—filters in place.

DESCRIPTION OF NAVY MASK, MARK II.

The Mark II, head canister type of gas mask, consists briefly of a closely fitting mask and rubberized cloth helmet. To this cloth helmet a light aluminum headpiece is attached by means of elastic straps. The aluminum headpiece forms a saddle to which the canister containing the chemical absorbents is strapped. A Y-shaped coupling is used for connecting the end of the canister with rubber tubes through which the air passes to the face piece. The filter pads consist of special felt layers separated by corrugated wire screen and are secured to each side of the headpiece. A cross tube of rubber connects the nozzle and filter pads to the intake end of the canister, so that air passing to the wearer's lungs must first pass through the filters, where the smoke is removed; thence through the chemical in the canister, where the poisonous elements of the gases are absorbed. The exhaled breath of the wearer is relieved through a rubber flutter valve, which projects vertically above the eyepieces. In order to prevent the exhaled breath from passing back through the canister, which would be injurious to the chemicals, small check valves are fitted at the lower ends of the rubber tubes. As a still further protection a disk check valve is fitted in the nozzle of the canister at the intake end. The incoming air is directed from the lower ends of the tubes so as to pass across the inside of the lenses, in order to prevent dimming.

In the case of true gases the poisonous elements are absorbed by certain chemicals contained in the canister of the outfit, the wearer drawing the outside air through this canister before it reaches his lungs. In the case of smokes the particles are actually filtered out of the air, which is drawn through filter pads strapped to the sides of the canister. The chemicals in the canister and the smoke pads afford protection against all forms of war gases known at present. For protection against carbon monoxide, which is not considered a war gas, the gray canister of the regular outfit is removed and replaced by a canister, painted black. containing special chemicals for changing carbon monoxide to carbon dioxide. (This black canister, however, is not regularly issued.)

ADJUSTMENT OF MASK TO FIT HEAD.

The aluminum headpiece should first be bent and molded to fit the head. The elastic webbing should then be adjusted so as to hold the headgear firmly. The straps which pass around the back of the head should next be adjusted so as to draw the mask snugly around the face. Some individuals having unusually hollow temples may find it necessary to slip paper under the straps and outside of the edge of the face piece in that locality, in order to prevent leakage.

The adjustment of the straps is important. If the straps are drawn up too tightly, the pressure will cause headache and discomfort and will increase the difficulty of putting on the mask quickly, while if the straps are too loose the mask will leak and permit the headgear to shift its position when the wearer moves suddenly. The most satisfactory adjustment will readily be found by experiment. When once properly fitted to the wearer this adjustment need not again be changed while the mask is used by the person to whom it is fitted.

The filter pads should be removed while making the necessary adjustment by releasing the retaining straps, care being exercised in replacing them to insure a firm gas-tight joint at the intake end of the canister.

PUTTING ON AND REMOVING THE GAS MASK.

The cuts show how the mask is put on and worn. The outfit is grasped in both hands, the thumbs being used to spread the part of the face piece that passes under the chin. The chin is then inserted in the face piece and with the body coming to an erect position the headgear is swept over the top of the head, the hands being used to spread out the face piece. By starting the operation in a stooping position with the canister resting on the knees as shown in figure 3, the back throw of the headgear and canister are utilized to bring the mask into position quickly.

While the mask is being put on, the breath should be held and then slowly expelled so that as the mask closes around the face the confined air, which supposedly is more or less poisoned, will be at least partly forced out through the flutter valve.

In taking off the mask the thumbs are inserted between the chin and the fabric. The mask is then stripped off with an upward and backward motion.

LIFE OF CHEMICALS.

The gray canister containing war gas absorbents will give protection for about six hours against concentrations of lethal gases such as are ordinarily met with in land warfare; for example, 50 parts per million of chlorpicrin. The black canister will give protection from carbon monoxide when new for a period of about six hours in an atmosphere containing 5,000 parts per million of carbon monoxide at 80 per cent relative humidity and 60 degrees F. This concentration might be expected in a compartment containing a smoldering fire. It should be understood that the carbon monoxide canister does not protect the wearer against oxygen deficiency. It sometimes happens that the oxygen contained in the atmosphere in a tightly closed compartment in which there is or has been a fire is very low. Under such circumstances, even though protected by a carbon monoxide mask, the wearer would still be exposed to the danger of oxygen starvation. By opening the hatches and doors this danger can be quickly removed.

GENERAL NOTES ON CARE OF CANISTERS AND MASKS.

The masks should be stored in as cool and dry a place as possible, because heat accelerates deterioration of the rubber.

The rubber caps must be kept over the canister spouts when the masks are not actually in use. This is particularly important in the case of the carbon monoxide (black) canisters. Air and moisture will quickly neutralize the chemicals in the carbon monoxide canister and render them ineffective.

In storing the masks care should be taken to prevent unnecessary bending of the rubber tubing.

Eyepieces should be cleaned frequently to give clear vision. A cracked lens does not necessarily mean a leaky lens, as the celluloid between the two thicknesses of glass will keep the lens air-tight.

Check and flutter valves should be examined periodically and tested to determine whether they are functioning properly.

In order to disinfect the mask the inside should be sponged out with a cloth which has been soaked in a 2 per cent solution of cresol or lysol. The tubes should be cleaned by means of a test-tube brush moistened with the same solution. The flutter valve may be readily disinfected by pressing the valve lightly between the forefinger and thumb in the transverse direction and dipping it in the disinfecting solution. The parts should be left moist with the disinfectant for about 15 minutes and should then be wiped dry.

NAVY AMMONIA GAS MASK.

This mask is the Navy Mark I gas mask fitted with a special chemical container.

INSTRUCTIONS FOR USE.

Masks should always be kept in the original box which protects them from moist air and light. They should not be stored near steam pipes or in any other hot place. If masks become wet in use, they should be dried before returning to box. Punctures should be promptly patched with adhesive tape, which is included in outfit. Masks torn beyond repair should not be used.

Regularly every week masks should be examined for defects. The glass eyepieces should be rubbed clean with a dry cloth, then smeared with ordinary soap—not wet—then again polished with a dry cloth. This prevents mist from forming on the inside of the glass when the mask is put on. Occasionally mist may form in spite of this treatment, and may be removed while the mask is in place on the head by inserting the thumbs in the loose fold of fabric adjacent to each eyepiece and rubbing the inside of the glass.

The chemical containers ought never to be unscrewed from the mask. In case this is done, however, it will be noted that several rubber washers are provided to make a tight seat. Any one of these is sufficient, and one or more may be omitted if necessary to secure a tight fit, with the rubber exhale valve pointing downward. The container needs to be screwed up with moderate force only.

The wire frame is for holding the goggles in position like a spectacle frame. It may be snapped into position over the goggles when desired, and will be found an aid to vision.

IMPORTANT.

Before using, prepare chemical container for ammonia gas only, as follows:

Remove the perforated bottom cap from the chemical container, then take the sponge and 25 layers of cotton gauze from the container, soak both the gauze and sponge in a saturated solution of tartaric acid, squeeze free from excess solution, place in position in chemical container, replacing the perforated bottom cap. The mask is now ready for use.

When finished using the mask, the gauze, and sponge are to be rinsed free of acid, dried. and returned to the container—the complete mask packed in its compartment of box.

RESUSCITATION BY THE PRONE-PRESSURE (SCHAEFER) METHOD OF ARTIFICIAL RESPIRATION—GAS ASPHYXIATION, DROWNING, ELECTRIC SHOCK.

Position.

Waste no time. Lay the victim on his belly, with one arm extended overhead, the other bent at the elbow; face turned to the side and resting on the forearm so that the mouth and nose are free for breathing.

Kneel straddling the patient's hips, with your knees just below his hip bones. Place your hands on the small of his back. Fingers extended over the lower ribs. Little finger over the last rib. Finger tips just out of your sight on the sides of the chest. (See fig. 1.)

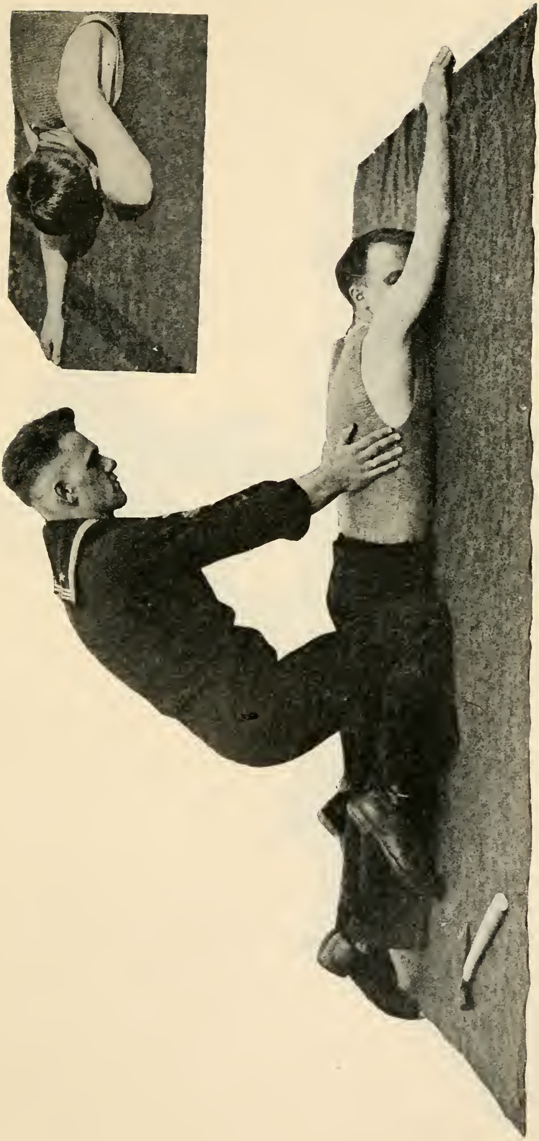


FIG. 1.

First Movement.

Make pressure while deliberately counting—one, two, three—as follows:

With arms straight, bring your weight to bear upon the patient gradually and heavily but not violently. Swing forward slowly. This movement should take three seconds. (See fig. 2.)

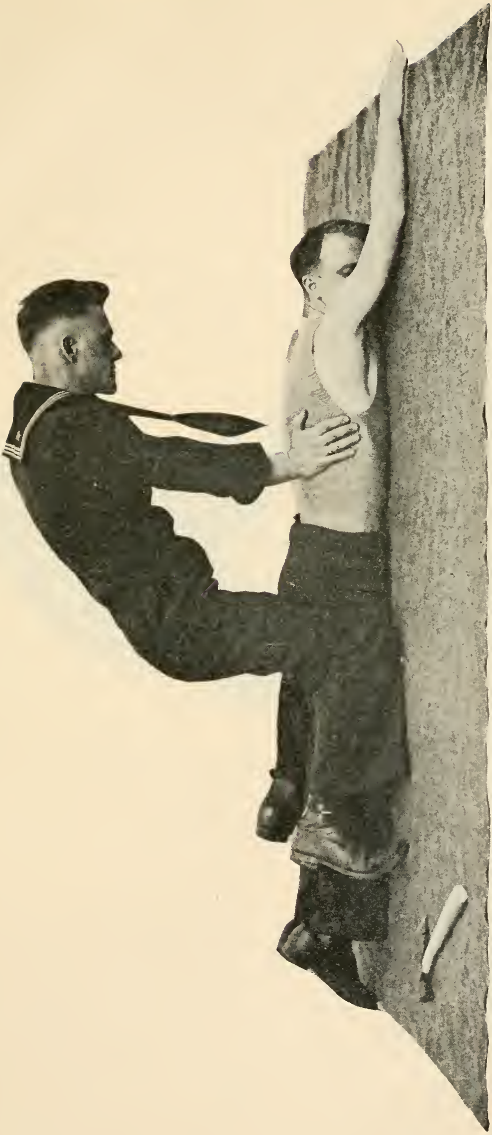


Fig. 2.

Second Movement.

Release the pressure suddenly by swinging back quickly to the position shown in figure 3. Rest while deliberately counting—one, two.

Repeat these movements from 12 to 15 times a minute; pressure three seconds; rest two seconds; complete respiration, five seconds—never less than four seconds.

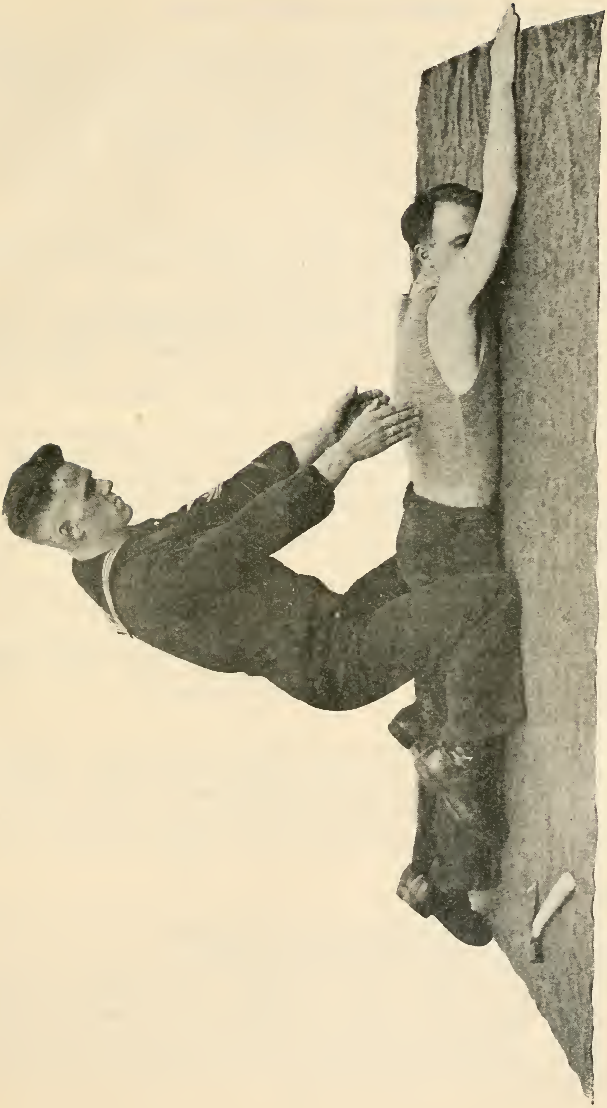


FIG. 3.

GENERAL DIRECTIONS.

Continue artificial respiration without interruption for four hours unless breathing is restored, or until a medical officer has declared further efforts futile. If natural breathing stops after temporary restoration, resume artificial respiration at once.

Watch carefully for signs indicating the return of natural breathing. Do not block feeble respiratory efforts. Time your movements so that pressure is exerted only while the patient is breathing out. Release pressure instantly when he begins to breathe in.

Keep the patient warm. Give him fresh air. Without interrupting resuscitation movements, have someone else loosen his clothing about the neck, chest, and waist.

Have someone hold the tongue out if it draws back. If necessary run a safety pin through the tongue in order to hold it. The small puncture wound thus caused will injure the tongue less than clamps or forceps which squeeze and crush it. The tongue is more likely to cause trouble in drowning cases than in other forms of asphyxia.

Do not attempt to give any liquid by mouth. Ammonia may be placed near the patient's nose after determining how close it may be brought to somebody else's nose without causing irritation. Do not let bystanders shut off fresh air.

Someone should smartly tap the patient's shoe heels with a stick or hatchet handle 15 or 20 times every 5 minutes until respiration has been restored.

If the patient revives, do not allow him to get up or to be raised for any purpose. *Keep him prone until a medical officer arrives.*

THE PRONE-PRESSURE METHOD OF ARTIFICIAL RESPIRATION SHOULD BE APPLIED BY ONE WHO HAS PRACTICED ON A VOLUNTARY SUBJECT.

Gas Asphyxiation.

Remove the victim from the poisonous atmosphere. If breathing has stopped or if it is slow and irregular, begin artificial respiration immediately at the nearest place where *fresh air* can be obtained. Notify the medical officer at once and send for oxygen. Keep the patient prone even though conscious. See page —.

Electric Shock.

Usually electric shock does not kill instantly. Life can often be saved even though breathing has stopped.

(1) *Free the victim from the circuit immediately.*—Use a dry nonconductor (rubber gloves, clothing, rope, board) to move either the victim or the wire. Beware of using metal or moist material. Shut off the current. If necessary to cut a live wire use an ax or hatchet with a *dry* wooden handle and turn your face away from the electrical flash.

(2) *Attend instantly to the victim's breathing.*—Begin artificial respiration at once, on the spot. Do not stop to loosen clothing; every moment counts. Feel with your finger in his mouth and throat for foreign bodies—tobacco, false teeth, etc.—and remove them. If the mouth is tightly shut pay no attention to it until it can be attended to without interfering with the application of artificial respiration.

Drowning.

As soon as the victim is taken from the water place him face downward. Clasp your hands under his stomach and lift his body several times, letting the head hang down, thus draining the stomach, throat, and lungs.

Quickly wipe out the mouth and throat with your fingers. Remove any foreign body. Do not waste a second.

Begin artificial respiration at once and continue without interruption.

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